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Jung et al.

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(54) **ORGANIC LAYER DEPOSITION APPARATUS AND METHOD OF MANUFACTURING ORGANIC LIGHT-EMITTING DISPLAY APPARATUS USING THE SAME**

(71) Applicant: **SAMSUNG DISPLAY CO., LTD.**, Yongin, Gyeonggi-Do (KR)

(72) Inventors: **Jae-Sun Jung**, Yongin (KR); **Byung-Min Jang**, Yongin (KR); **Na-Jeong Kim**, Yongin (KR)

(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**, Yongin, Gyeonggi-Do (KR)

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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H01L 51/56	(2006.01)
C23C 14/04	(2006.01)
C23C 14/24	(2006.01)
C23C 14/56	(2006.01)
H01L 21/677	(2006.01)
H01L 21/683	(2006.01)
H01L 51/00	(2006.01)

(52) **U.S. Cl.**

CPC ***H01L 51/56*** (2013.01); ***C23C 14/042*** (2013.01); ***C23C 14/24*** (2013.01); ***C23C 14/568*** (2013.01); ***H01L 21/6776*** (2013.01); ***H01L 21/67709*** (2013.01); ***H01L 21/6831*** (2013.01); *H01L 51/0003* (2013.01)

(58) **Field of Classification Search**

CPC H01L 51/0002; H01L 21/6776; H01L 51/0003; H01L 51/0008; H01L 51/0011; H01L 51/0014; H01L 51/0025; H01L 51/0032; H01L 2251/566; H01L 2924/12044

See application file for complete search history.

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Primary Examiner — Thanh Y Tran

(74) *Attorney, Agent, or Firm* — F. Chau & Associates, LLC

(57) **ABSTRACT**

An organic layer deposition apparatus includes a conveyer unit and a deposition unit that has one or more organic layer deposition assemblies configured to deposit an organic layer on a moving substrate. The conveyer unit includes a moving unit configured to move a substrate fixed thereto, a first conveyer unit configured to move the moving unit in a first direction during which an organic material is deposited on the substrate fixed to the moving unit, and a second conveyer unit configured to move the moving unit in a second direction opposite to the first direction after deposition is completed and the substrate is separated from the moving unit. The first conveyer unit and the second conveyer unit are configured to move through the deposition unit.

5 Claims, 8 Drawing Sheets

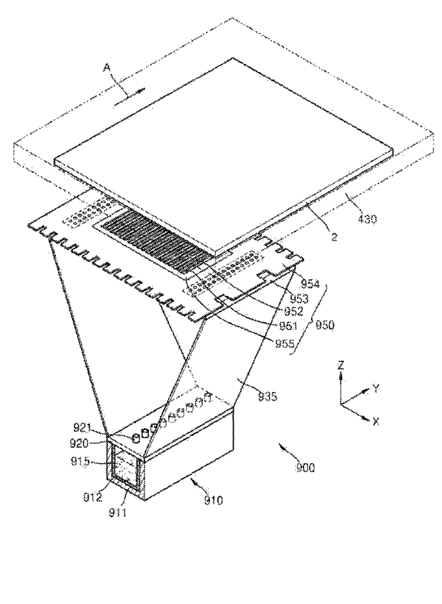


FIG. 1

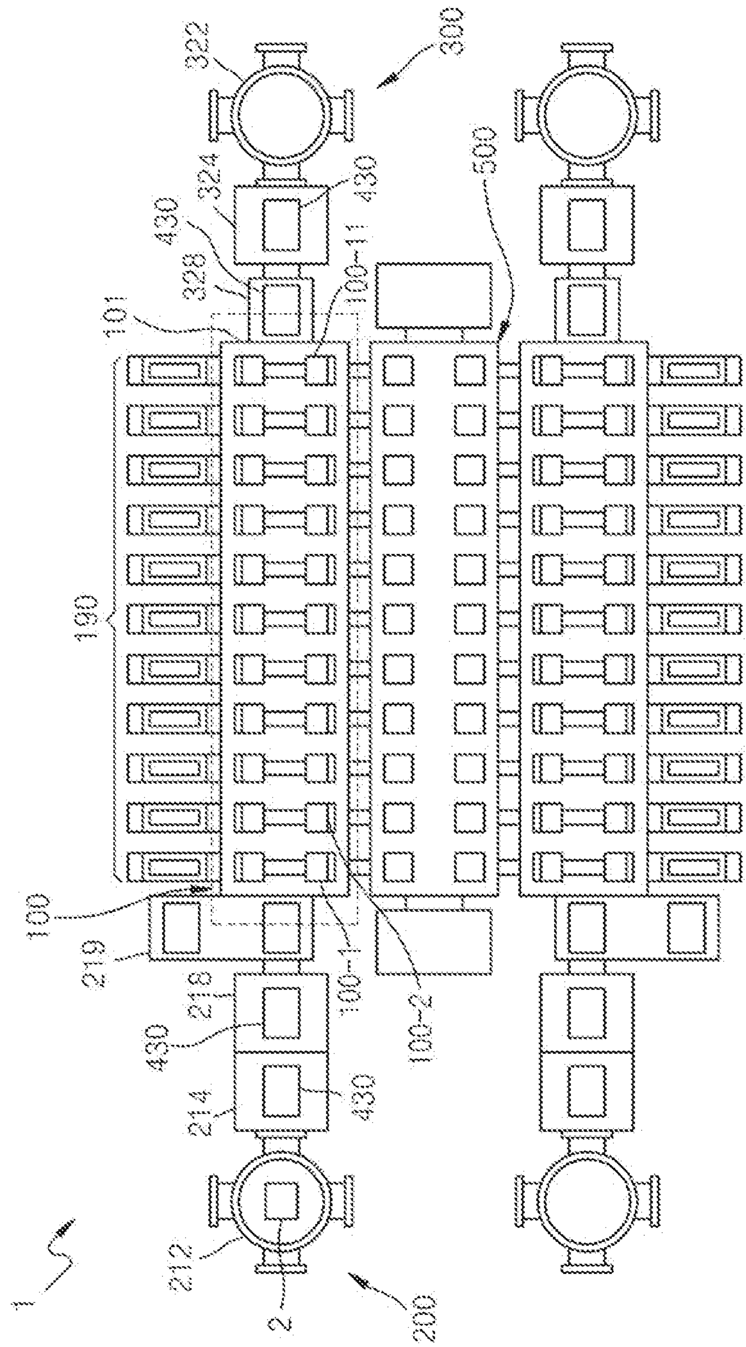

322
300
324
430
430
328
101
100-11
500
190
100
219
218
430
100-1
100-2
214
430
212
2
200
1

FIG. 2

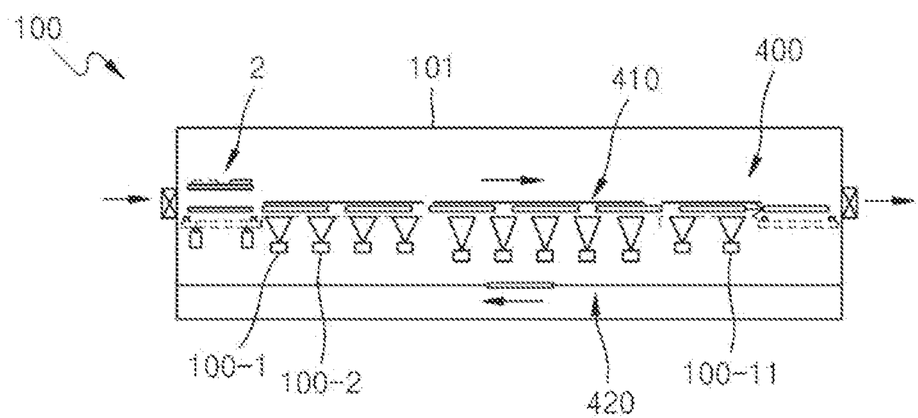


FIG. 3

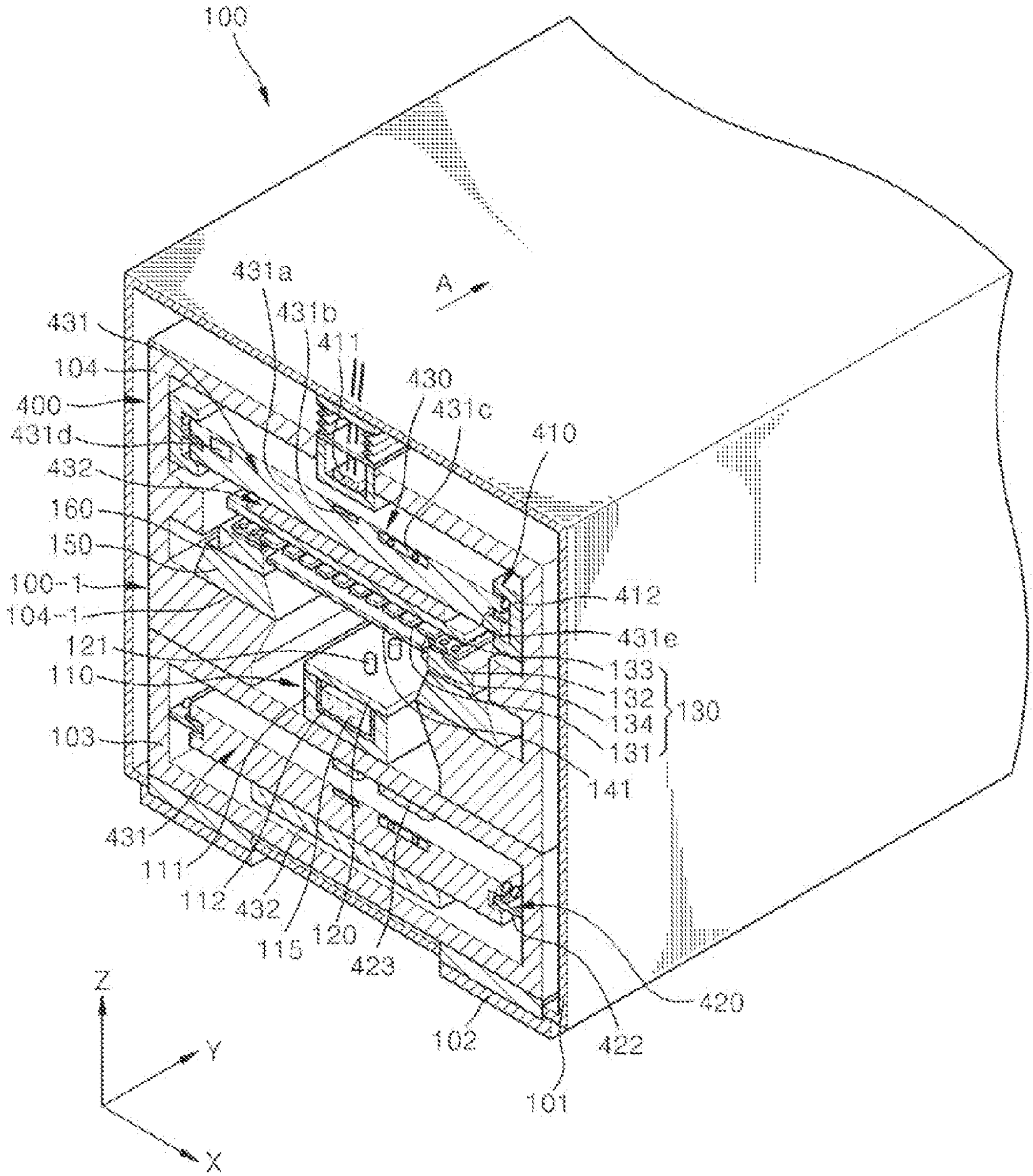

100
431a
A
431b
411
430
431c
410
431
104
400
431d
432
160
150
100-1
104-1
121
110
103
412
431e
133
132
134
131
130
141
431
111
112
432
115
120
423
420
422
102
101
Z
Y
X

FIG. 4

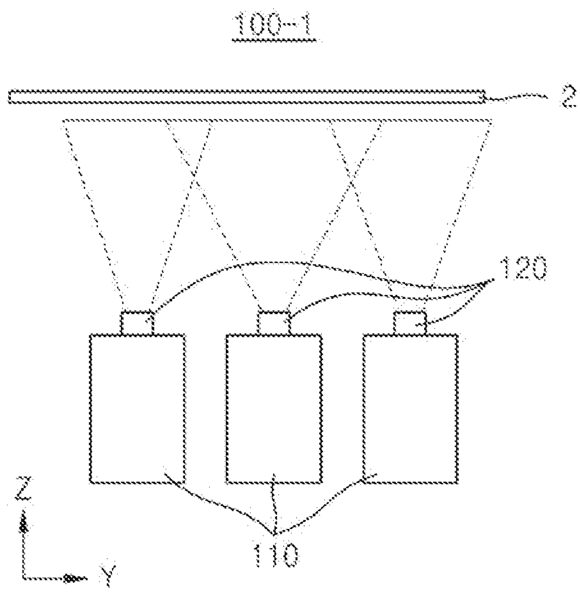


FIG. 5

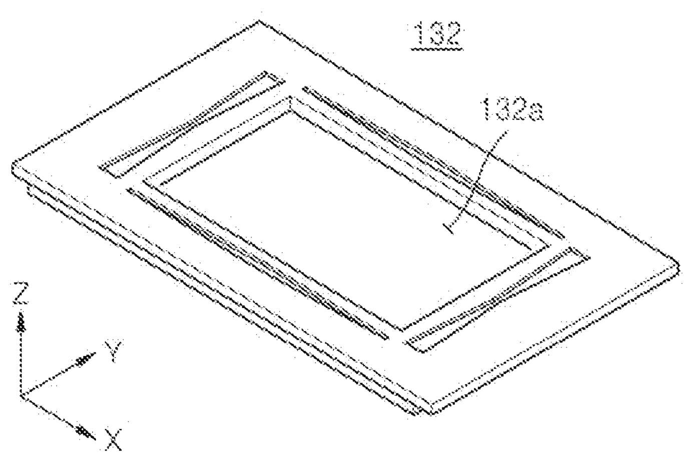


FIG. 6

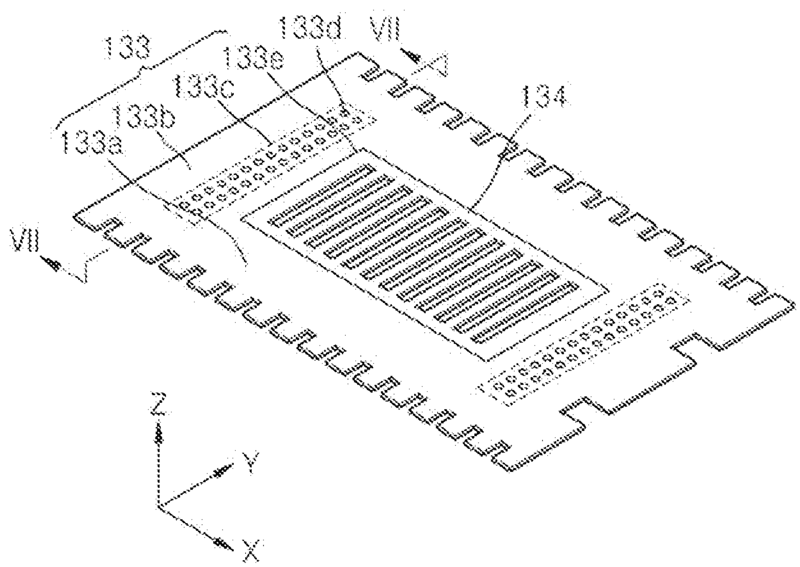


FIG. 7

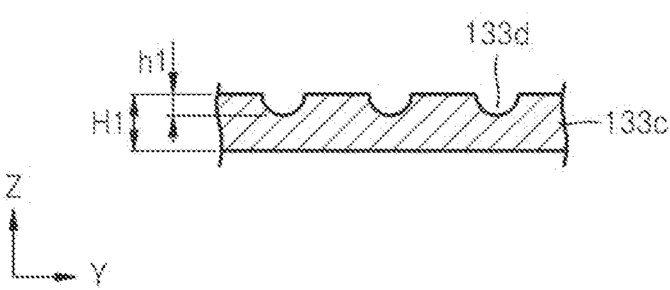


FIG. 8

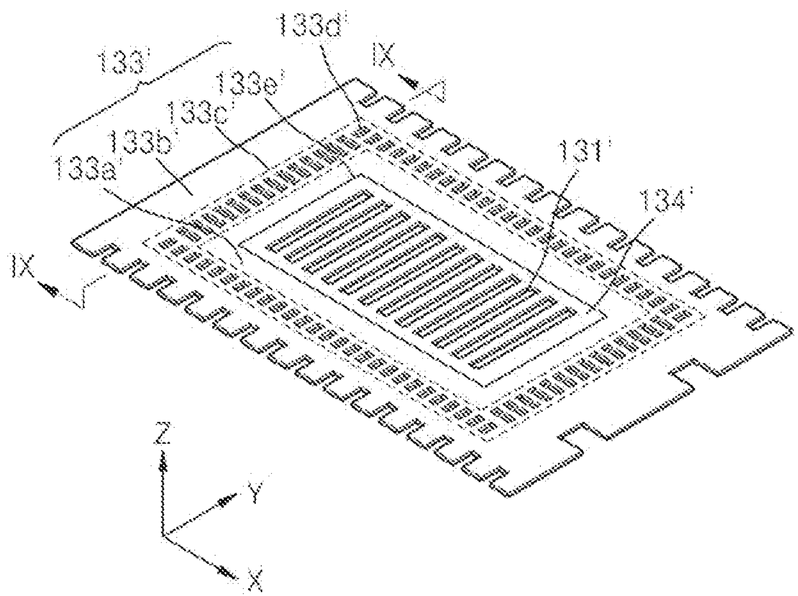

133'
133d'
IX
133e'
133c'
133b'
133a'
131'
134'
IX
Z
Y
X

FIG. 9

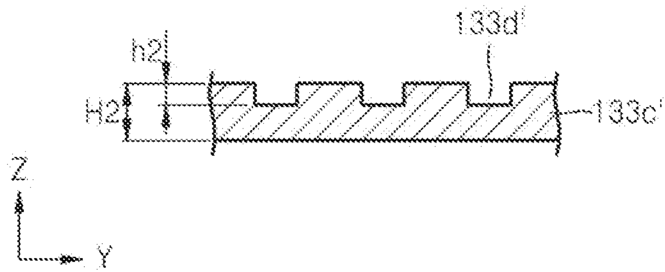

133d'
h2
H2
133c'
Z
Y

FIG. 10

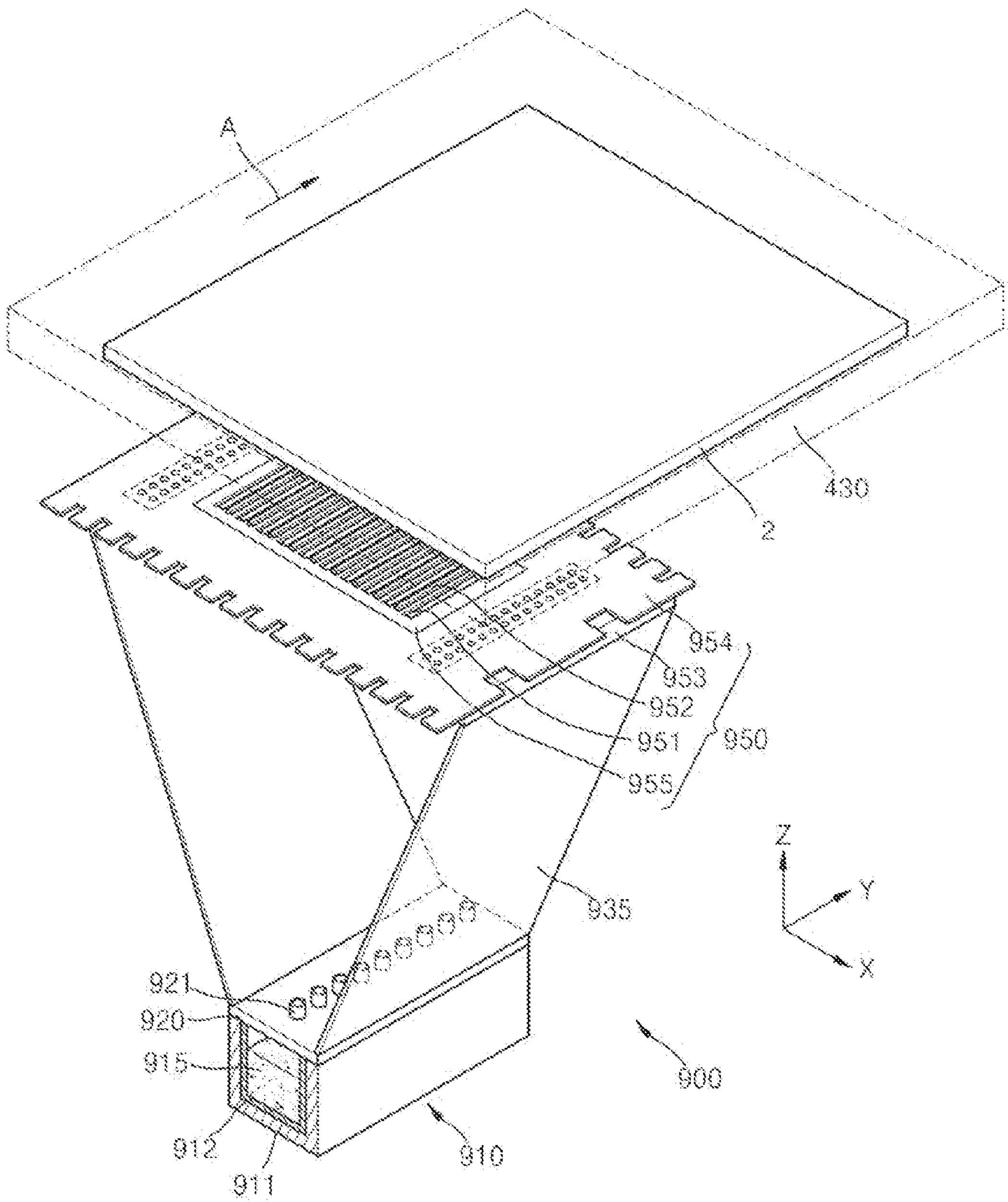
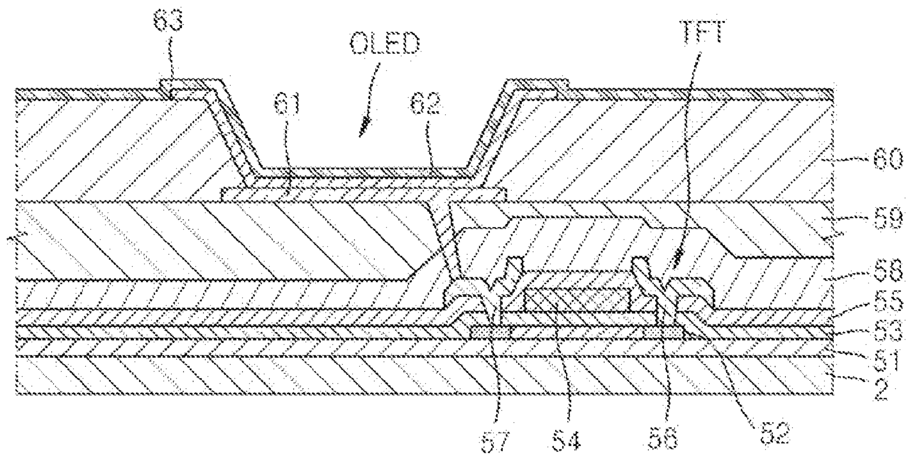

A
430
2
954
953
952
951
950
955
935
Z
Y
X
921
920
915
912
911
910
900

FIG. 11



ORGANIC LAYER DEPOSITION APPARATUS AND METHOD OF MANUFACTURING ORGANIC LIGHT-EMITTING DISPLAY APPARATUS USING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. §119 from Korean Patent Application No. 10-2013-0063080, filed on May 31, 2013, in the Korean Intellectual Property Office, and all the benefits accruing therefrom, the contents of which are herein incorporated by reference in their entirety.

BACKGROUND

1. Technical Field

Embodiments of the present disclosure are directed to an organic layer deposition apparatus and a method of manufacturing an organic light-emitting display apparatus using the same.

2. Discussion of the Related Art

Organic light-emitting display devices have attracted attention as a next-generation display apparatus because of their wide viewing angle, high contrast, and fast response time.

An organic light-emitting display apparatus includes an intermediate layer that includes an emission layer disposed between a first electrode and a second electrode which face each other. In this case, the first and second electrodes and the intermediate layer may be formed using various methods. One method is an independent deposition method. A deposition method uses a fine metal mask (FMM) having the same pattern as a pattern to be formed in an organic layer. To manufacture an organic light-emitting display apparatus using a deposition method, the FMM is closely attached to a surface of a substrate on which the organic layer is to be formed, an organic layer material may be deposited, and the patterned organic layer may be formed.

However, using an FMM may increase an area of the organic light-emitting display apparatus by using a large mother glass. This is because when a large mask is used, the large mask may bend due to its weight and thus the pattern may be distorted, which can deteriorate a fine pitch pattern.

Furthermore, it is time-consuming to align and closely attach the substrate and the FMM, perform deposition, and separate the substrate from the FMM, which can lengthen the manufacturing time and lower production efficiency.

SUMMARY

Embodiments of the disclosure can provide an organic layer deposition apparatus and a method of manufacturing an organic light-emitting display apparatus using the same, which may ensure an easier manufacturing process, more easily mass produce large substrates, and form finer pitch pattern.

According to an aspect of the present disclosure, there is provided an organic layer deposition apparatus, the apparatus including: a deposition unit that includes one or more organic layer deposition assemblies configured to deposit an organic layer on a moving substrate, wherein each of the one or more organic layer deposition assemblies includes: a deposition source configured to discharge a deposition material; and a patterning slit sheet disposed to face the deposition source, wherein the patterning slit sheet includes: a first fixing frame; a second fixing frame attached to the first fixing frame, the second fixing frame having at least one portion whose thickness is less than thicknesses of other portions; and a pattern sheet that is fixed to the second fixing frame to face the deposition source and which has a plurality of pattern slits.

The second fixing frame may include: a first fixing portion to which the pattern sheet is fixed; a second fixing portion to which the first fixing frame is fixed; and at least one etching portion formed on at least one of the first fixing portion and the second fixing portion and has at least one portion whose thickness is different from a thickness of the at least one of the first fixing portion and the second fixing portion.

At least one etching indentation may be formed in a surface of the at least one etching portion.

The at least one etching portion may surround an edge of the pattern sheet.

The deposition material discharged by the deposition source may flow through the patterning slit sheet to form a pattern on the moving substrate.

A length of the patterning slit sheet may be less than a length of the moving substrate along a moving direction of the moving substrate.

The organic layer deposition apparatus may include a conveyer unit that includes a moving unit configured to move a substrate fixed thereto, a first conveyer unit configured to move the moving unit in a first direction during which an organic material is deposited on the substrate fixed to the moving unit, and a second conveyer unit configured to move the moving unit in a second direction opposite to the first direction after deposition is completed and the substrate is separated from the moving unit. The first conveyer unit and the second conveyer unit may be configured to move through the deposition unit.

The first conveyer unit and the second conveyer unit may be vertically spaced apart from each other.

The moving unit may be configured to be transferred between the first conveyer unit and the second conveyer unit, and the substrate fixed to the moving unit may be spaced apart from the organic layer deposition assembly by a predetermined interval while being moved by the first conveyer unit.

According to another aspect of the present disclosure, there is provided a method of manufacturing an organic light-emitting display apparatus using an organic layer deposition apparatus, the method including: fixing a substrate to a moving unit; transferring a moving unit to which the substrate is fixed into a chamber by using a first conveyer unit that is configured to enter the chamber, wherein the substrate is spaced apart from an organic layer deposition assembly disposed in the chamber by a predetermined interval, depositing a deposition material discharged from the organic layer deposition assembly on the substrate while the substrate moves relative to the organic layer deposition assembly, to form an organic layer; separating the substrate from the moving unit; and returning the moving unit using a second conveyer unit that is configured to enter the chamber. The organic layer deposition assembly includes: at least one deposition source configured to discharge the deposition material; and a patterning slit sheet that is disposed to face each of the plurality of deposition sources. The deposition material discharged from the organic layer deposition assembly flows through the patterning slit sheet to form a pattern on the moving substrate.

The patterning slit sheet may further include a first fixing frame, a second fixing frame attached to the first fixing frame, the second fixing frame having at least one portion whose thickness is less than thicknesses of other portions, and a pattern sheet fixed to the second fixing frame to face organic layer deposition assembly, and which has a plurality of patterning slits.

The second fixing frame may include: a first fixing portion to which the pattern sheet is fixed; a second fixing portion to which the first fixing frame is fixed; and at least one etching portion formed on at least one of the first fixing portion and the second fixing portion, and has at least one portion whose thickness is different from a thickness of the at least one of the first fixing portion and the second fixing portion.

At least one etching indentation may be formed in a surface of the at least one etching portion.

The at least one etching portion may surround an edge of the pattern sheet.

The moving unit may be configured to be transferred between the first conveyer unit and the second conveyer unit, and the substrate fixed to the moving unit may be spaced apart from the organic layer deposition assembly by a predetermined interval while being moved by the first conveyer unit.

According to another aspect of the present disclosure, there is provided an organic layer deposition apparatus, including a conveyer unit and a deposition unit comprising one or more organic layer deposition assemblies configured to deposit an organic layer on a moving substrate. The conveyer unit includes a moving unit configured to move a substrate fixed thereto, a first conveyer unit configured to move the moving unit in a first direction during which an organic material is deposited on the substrate fixed to the moving unit, and a second conveyer unit configured to move the moving unit in a second direction opposite to the first direction after deposition is completed and the substrate is separated from the moving unit. The first conveyer unit and the second conveyer unit are configured to move through the deposition unit.

Each of the one or more organic layer deposition assemblies may include

a deposition source configured to discharge a deposition material, and a patterning slit sheet disposed to face the deposition source. The patterning slit sheet may include a first fixing frame, a second fixing frame attached to the first fixing frame, the second fixing frame having at least one portion whose thickness is less than thicknesses of other portions, and a pattern sheet that is fixed to the second fixing frame to face the deposition source, and which has a plurality of pattern slits. The deposition material discharged by the deposition source may flow through the patterning slit sheet to form a pattern on the moving substrate.

The second fixing frame may include a first fixing portion to which the pattern sheet is fixed, a second fixing portion to which the first fixing frame is fixed, at least one etching portion formed on at least one of the first fixing portion and the second fixing portion that has at least one portion whose thickness is different from a thickness of the at least one of the first fixing portion and the second fixing portion, and at least one etching indentation formed in a surface of the at least one etching portion.

The first conveyer unit and the second conveyer unit may be vertically spaced apart from each other.

The moving unit may be configured to be transferred between the first conveyer unit and the second conveyer unit, and the substrate fixed to the moving unit may be spaced apart from the organic layer deposition assembly by a predetermined interval while being moved by the first conveyer unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of an organic layer deposition apparatus according to an embodiment of the present disclosure.

FIG. **2** is a side view of a deposition unit of the organic layer deposition apparatus of FIG. **1**.

FIG. **3** is a perspective view of the deposition unit of FIG. **1**.

FIG. **4** is a cross-sectional view of an organic layer deposition assembly of

FIG. **3**.

FIG. **5** is a perspective view of a first fixing frame of FIG. **3**.

FIG. **6** is a perspective view of a second fixing frame and a pattern sheet of FIG. **3**.

FIG. **7** is a cross-sectional view taken along line VII-VII of FIG. **6**.

FIG. **8** is a perspective view of a second fixing frame of FIG. **3** according to another embodiment of the present disclosure;

FIG. **9** is a cross-sectional view taken along line IX-IX of FIG. **8**.

FIG. **10** is a perspective view of an organic layer deposition assembly according to another embodiment of the present disclosure.

FIG. **11** is a cross-sectional view of an active matrix organic light-emitting display apparatus manufactured using an organic layer deposition apparatus according to an embodiment of the present disclosure.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Hereinafter, embodiments of the present disclosure will be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the disclosure are shown. Embodiments of the disclosure may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein.

FIG. **1** is a plan view of an organic layer deposition apparatus **1** according to an embodiment of the present disclosure. FIG. **2** is a side view of a deposition unit **100** of the organic layer deposition apparatus **1** of FIG. **1**.

Referring to FIGS. **1** and **2**, the organic layer deposition apparatus **1** includes the deposition unit **100**, a loading unit **200**, an unloading unit **300**, and a conveyer unit **400**.

The loading unit **200** may include a first rack **212**, a transport chamber **214**, a first inversion chamber **218**, and a buffer chamber **219**.

A plurality of substrates **2** upon which deposition is to be performed are stacked on the first rack **212**. A transport robot provided in the transport chamber **214** picks up one of the substrates **2** from the first rack **212**, places the substrate **2** on a moving unit **430** transferred from a second conveyer unit **420**, and moves the moving unit **430** with the attached substrate **2** into the first inversion chamber **218**.

The first inversion chamber **218** is disposed adjacent to the transport chamber **214**, and a first inversion robot located in the first inversion chamber **218** inverts the moving unit **430** and loads the inverted moving unit **430** onto a first conveyer unit **410** of the deposition unit **100**.

In FIG. **1**, the transport robot of the transport chamber **214** places the substrate **2** on a top surface of the moving unit **430**, and in this state, the moving unit **430** is transferred into the inversion chamber **218**. As the first inversion robot of the first inversion chamber **218** inverts the first inversion chamber **218**, the substrate **2** is turned upside down in the deposition unit **100**.

The unloading unit **300** is configured to operate in an opposite manner to the loading unit **200**. That is, a second inversion robot in a second inversion chamber **328** inverts the substrate **2** and the moving unit **430** and moves the inverted substrate **2** and moving unit **430** into an ejection chamber **324**.

An ejection robot takes the substrate **2** and the moving unit **430** out of the ejection chamber **324**, separates the substrate **2** from the moving unit **430**, and loads the substrate **2** onto a second rack **322**. The moving unit **430** is returned to the loading unit **200** through the second conveyer unit **420**.

However, embodiments are not limited thereto. For example, when the substrate **2** is first fixed to the moving unit **430**, the substrate **2** may be fixed to a bottom surface of the moving unit **430** and then directly moved into the deposition unit **100**. In this case, the first inversion robot of the first inversion chamber **218** and the second inversion robot of the second inversion chamber **328** may be omitted.

The deposition unit **100** includes at least one chamber **101** for deposition. The deposition unit **100** includes a plurality of organic layer deposition assemblies, referred to as the first organic layer deposition assembly **100-1**, the second organic layer deposition assembly **100-2**, . . . , and the eleventh organic layer deposition assembly **100-11**, disposed in the chamber **101**. In this case, although 11 organic deposition assemblies are shown in the chamber **101**, this number is exemplary and non-limiting, and the number of organic layer deposition assemblies may vary according to a deposition material **115** (see FIG. **3**) and a deposition condition. The chamber **101** is maintained in a vacuum while deposition is performed. In this case, since each of the plurality of organic layer deposition assemblies are similar to each other, the following explanation will focus on the first organic layer deposition assembly **100-1**.

The moving unit **430** to which the substrate **2** is fixed is sequentially moved by the first conveyer unit **410** to the loading unit **200**, the deposition unit **100**, and the unloading unit **300**, where the moving unit **430** is separated from the substrate **2**, and the separated moving unit is returned to the loading unit **200** by the second conveyer unit **420**.

The first conveyer unit **410** enters the chamber **101** of the deposition unit **100**, and the second conveyer unit **420** is provided to transfer the moving unit **430** separated from the substrate **2**.

The first conveyer unit **410** and the second conveyer unit **420** are vertically spaced apart from each other. The moving unit **430** is subjected to deposition while passing through chamber **101** on the first conveyer unit **410**, separated from the substrate **2** in the unloading unit **300**, and is returned to the loading unit **200** on the second conveyer unit **420** disposed under the first conveyer unit **410**, thereby improving space utilization efficiency of the organic layer deposition apparatus **1**.

The deposition unit **100** of FIG. **1** may further include a deposition source replacement unit **190** disposed at a side of each organic layer deposition assembly, for example, along side of each of the first organic layer deposition assembly **100-1** to the eleventh organic layer deposition assembly **100-11**. Although not shown in detail, the deposition source replacement unit **190** may be a cassette that is externally disposed with respect to the first organic layer deposition assembly **100-1**. Accordingly, a deposition source **110** (see FIG. **3**) of each of the organic layer deposition assemblies **100-1**, . . . , **100-11** may be easily replaced.

The organic layer deposition apparatus **1** shown in FIG. **1** includes two sets of the loading unit **200**, the deposition unit **100**, the unloading unit **300**, and the conveyer unit **400**. That is, it would be understood that two organic layer deposition apparatuses **1** are disposed along side of each other in FIG. **1**. In this case, a patterning slit sheet replacement unit **500** may be further provided between the two organic layer deposition apparatuses **1**. Since the patterning slit sheet replacement unit **500** is provided between the two organic layer deposition apparatuses **1** so that the two organic layer deposition apparatuses **1** may share the patterning slit sheet replacement unit **500**, space utilization may be improved with respect to a case when each organic layer deposition apparatus **1** includes its own patterning slit sheet replacement unit **500**.

FIG. **3** is a perspective view of the deposition unit **100** of FIG. **1**. FIG. **4** is a cross-sectional view of the deposition unit **100** of FIG. **3**.

Referring to FIGS. **3** and **4**, the deposition unit **100** of the organic layer deposition apparatus **1** includes at least one organic layer deposition assembly and the conveyer unit **400**. Since each of the organic layer deposition assemblies are similar to each other, the following explanation will focus on the first organic layer deposition assembly **100-1**.

An overall structure of the deposition unit **100** will now be described.

The chamber **101** has a hollow box shape, and the at least one organic layer deposition assembly and the conveyer unit **400** are received in the chamber **101**. The chamber **101** includes a foot **102** to be fixed to the ground, a lower housing **103** disposed on the foot **102**, and an upper housing **104** disposed on the lower housing **103**. The chamber **101** is configured to receive both the lower housing **103** and the upper housing **104** therein. A connection portion between the lower housing **103** and the chamber **101** is sealed to completely isolate an inside of the chamber **101** from the outside. As such, since the lower housing **103** and the upper housing **104** are disposed on the foot **102**, even when the chamber **101** repeatedly contracts and expands, the lower housing **103** and the upper housing **104** may be maintained in fixed positions. Accordingly, the lower housing **103** and the upper housing **104** may function as reference frames in the deposition unit **100**.

The first organic layer deposition assembly **100-1** and the first conveyer unit **410** of the conveyer unit **400** are disposed in the upper housing **104**, and the second conveyer unit **420** of the conveyer unit **400** is disposed in the lower housing **103**. Deposition is continuously performed as the moving unit **430** is transferred by the first conveyer unit **410** to the second conveyer unit **420**.

A detailed structure of the first organic layer deposition assembly **100-1** will be described.

The first organic layer deposition assembly **100-1** includes a plurality of deposition sources **110**, a deposition source nozzle unit **120**, a patterning slit sheet **130**, a plurality of source shutters **141**, a first stage **150**, and a second stage **160**. All elements of FIGS. **3** and **4** may be disposed in the chamber **101**, which is maintained in an appropriate vacuum state. This structure is used to deposit the deposition material **115** in a straight line.

The substrate **2** upon which deposition is to be performed is disposed in the chamber **101**. The substrate **2** may be a substrate for a flat panel display apparatus. A large substrate having a size equal to or greater than 40 inches, such as a mother glass for forming a plurality of flat panel display apparatuses, may be used.

Deposition is performed as the substrate **2** moves relative to the first organic layer deposition assembly **100-1**.

In detail, in a conventional fine metal mask (FMM) deposition method, an FMM size should be the same as a substrate size. Accordingly, as the substrate size increases, an FMM size needs to increase, which makes it more challenging to manufacture an FMM, to elongate an FMM, or to align the FMM in a precise pattern.

To address these issues, deposition is performed as the first organic layer deposition assembly **100-1** and the substrate **2** move relative to each other. In other words, deposition is continuously performed as the substrate **2**, which faces the first organic layer deposition assembly **100-1**, moves in a Y-axis direction, as indicated in FIG. **3**. That is, deposition is performed by scanning as the substrate **2** moves in a direction indicated by an arrow A of FIG. **3**. Although deposition is performed as the substrate **2** moves in the Y-axis direction in the chamber in FIG. **3**, embodiments are not limited thereto. For example, the substrate **2** may be fixed, and deposition may be performed as the first organic layer deposition assembly **100-1** moves in the Y-axis direction.

Accordingly, in the first organic layer deposition assembly **100-1**, the patterning slit sheet **130** may be much smaller than a conventional FMM. That is, in the first organic layer deposition assembly **100-1**, deposition is continuously performed by scanning as the substrate **2** moves in the Y-axis direction. Accordingly, a length of the patterning slit sheet **130** in at least one of an X-axis direction or the Y-axis direction may be less than a length of the substrate **2**. Since the patterning slit sheet **130** may be smaller than a conventional FMM, it may be easier to manufacture the patterning slit sheet **130**.

To perform deposition as the first organic layer deposition assembly **100-1** and the substrate **2** move relative to each other, the first organic layer deposition assembly **100-1** **2** may be spaced apart from the substrate by a predetermined interval, which will be described below in detail.

The plurality of deposition sources **110** in which deposition material **115** is received and heated are disposed in the chamber to face the substrate **2**. As the deposition material **115** evaporates in each of the plurality of deposition sources **110**, the evaporated deposition material is deposited on the substrate **2**.

In detail, each of the plurality of deposition sources **110** includes a crucible **111** in which the deposition material **115** is filled, and a heater **112** that heats the crucible **111** to vaporize the deposition material **115** filled in the crucible **111** so that the vaporized deposition material flows toward the deposition nozzle unit **120**.

The deposition nozzle unit **120** is disposed at a side of the deposition source **110** facing the substrate **2**. The first organic layer deposition assembly **100-1** may have different deposition source nozzles for depositing a common layer and a pattern layer.

The patterning slit sheet **130** is provided between each deposition source **110** and the substrate **2**. The patterning slit sheet **130** may include a first fixing frame **132**, a second fixing frame **133**, and a pattern sheet **134**. According to embodiments, the second fixing frame **133** may be provided on the first fixing frame **132**, and the pattern sheet **134** may be provided on the second fixing frame **133**. According to embodiments, the pattern sheet **134** may be formed to have substantially the same shape as a window frame, and a plurality of patterning slits **131** may be formed in the X-axis direction in the pattern sheet **134**.

The deposition material **115** evaporating in each deposition source **110** is discharged through the deposition source nozzle unit **120** and the patterning slit sheet **130** toward the substrate **2** on which deposition is to be performed. According to embodiments, the patterning slit sheet **130** may be manufactured using etching, which is the same method used for manufacturing a conventional FMM, such as a stripe type mask. According to embodiments, the total number of patterning slits **131** may be greater than a total number of deposition source nozzles **121**.

The patterning slit sheet **130** may be spaced apart from each deposition source **110** and deposition source nozzle unit **120** coupled thereto by a predetermined interval.

As described above, deposition is performed as the first organic layer deposition assembly **100-1** moves relative to the substrate **2**, and for the first organic layer deposition assembly **100-1** to move relative to the substrate **2**, the patterning slit sheet **130** is spaced apart from the substrate **2** by a predetermined interval.

In detail, in a conventional FMM deposition method, a deposition process is performed by attaching a mask close to a substrate to prevent a shadow from being formed on the substrate. However, when the mask is attached close to the substrate, defects may occur due to contact between the substrate and the mask. In addition, since the mask does not move relative to the substrate, the mask should be formed to have the same size as that of the substrate. Accordingly, as a display apparatus size increases, a mask size has to increase. However, in a conventional FMM deposition method, it is challenging to form a large mask.

To address these issues, in the first organic layer deposition assembly **100-1**, the patterning slit sheet **130** is disposed to be spaced apart from the substrate **2** by a predetermined interval.

According to a present embodiment, since the patterning slit sheet **130** is smaller than the substrate **2** and deposition is performed as the patterning slit sheet **130** moves relative to the substrate **2**, the patterning slit sheet **130** may be more easily manufactured. Also, defects due to contact between the substrate **2** and the patterning slit sheet **130** may be avoided. In addition, since there is no need to closely attach the substrate **2** and the patterning slit sheet **130**, a manufacturing speed may be increased.

Next, detailed arrangement of elements in the upper housing **104** will be described.

The deposition source **110** and the deposition source nozzle unit **120** are disposed on the bottom of the upper housing **104**. Accommodation portions **104-1** protrude from both sides of the upper housing **104**, and the first stage **150**, the second stage **160**, and the patterning slit sheet **130** are sequentially formed on the accommodation portions **104-1**.

The first stage **150** is configured to move in the X-axis direction and the Y-axis direction to align the patterning slit sheet **130** in the X-axis and Y-axis directions. That is, the first stage **150** includes a plurality of actuators which may move in the X-axis and Y-axis directions relative to the upper housing **104**.

The second stage **160** is configured to move in a Z-axis direction to align the patterning slit sheet **130** in the Z-axis direction. That is, the second stage **160** includes a plurality of actuators which move in the Z-axis direction relative to the first stage **150**.

The patterning slit sheet **130** is disposed on the second stage **160**. As such, since the patterning slit sheet **130** is disposed on the first stage **150** and the second stage **160**, it moves in the X-, Y-, and Z-axis directions so that the substrate **2** and the patterning slit sheet **130** may be aligned with each other.

The upper housing **104**, the first stage **150**, and the second stage **160** may prevent the deposition material **115** discharged through the deposition source nozzles **121** from being dispersed. That is, a path of the deposited deposition material **115** is determined by the upper housing **104**, the first stage **150**, and the second stage **160**, which thus simultaneously guide the deposition of the deposition material **115** in both the X-axis direction and the Y-axis direction.

The plurality of source shutters **141** may be further provided between the patterning slit sheet **130** and the deposition source **110**. The plurality of source shutters **141** may block the deposition material **115** discharged from the deposition source **110**.

In addition, a shielding member may be further provided in the deposition unit **100** for preventing organic material from being deposited on a non-film formation area of the substrate **2**. The shielding member may be configured to move along with the substrate **2** while covering an edge portion of the substrate **2**, and thus covers the non-film formation area of the substrate **2**, organic material may be prevented from being deposited on the non-film formation area of the substrate **2**.

In addition, a plurality of source shutter driving units may be further provided in the deposition unit **100** for respectively moving the plurality of source shutters **141**. According to embodiments, each of the source shutter driving units may include a motor and a gear assembly, or a cylinder. However, embodiments of the source shutter driving unit are not limited thereto, and may include any device that can linearly move the source shutters **141**.

The conveyer unit **400** for transferring the substrate **2** on which deposition is to be performed will be described in detail. Referring to FIGS. **3** and **4**, the conveyer unit **400** includes the first conveyer unit **410**, the second conveyer unit **420**, and the moving unit **430**.

The first conveyer unit **410** linearly transfers the moving unit **430**, which includes a carrier **431** and an electrostatic chuck **432** coupled to the carrier **431**, and the substrate **2** attached to the moving unit **430**, so that an organic layer is deposited on the substrate **2** due to the first organic layer deposition assembly **100-1**.

The moving unit **430** is separated from the substrate **2** in the unloading unit **300** after one deposition is completed in the deposition unit **100**, after which the second conveyer unit **420** returns the moving unit **430** to the loading unit **200**.

The second conveyer unit **420** includes a roller guide **422**, and a charging track **423**.

The moving unit **430** that is transferred along the first conveyer unit **410** and the second conveyer unit **420** includes the carrier **431** and the electrostatic chuck **432** coupled to one surface of the carrier **431** and to which the substrate **2** is attached.

Each of elements of the conveyer unit **400** will be described in further detail.

The carrier **431** of the moving unit **430** will now be described in detail.

The carrier **431** includes a main body portion **431***a*, a linear motion system (LMS) magnet **431***b*, referred to herein below as a magnetic rail, a contactless power supply (CPS) module **431***c*, a power supply unit **431***d*, and guide grooves **431***e*.

The main body portion **431** is a base portion of the carrier **431**, and may be formed of a magnetic material such as iron. The carrier **431** may be spaced apart from a guide unit **412** includes the carrier **431** due to a magnetic force between the main body portion **431***a* and a magnetically suspended bearing.

The guide grooves **431***e* may be formed in both side surfaces of the main body portion **431***a*, and guide protrusions of the guide unit **412** may be received in the guide grooves **431***e*.

The magnetic rail **431***b* may be disposed along a central line of the main body portion **431***a* along a translation direction of the main body portion **431***a*. The magnetic rail **431***b* of the main body portion **431***a* and a coil **411** (explained below) may be coupled to each other to form a linear motor, which may transfer the carrier **431** in a direction indicated by an arrow A.

The CPS module **431***c* and the power supply unit **431***d* may be disposed on one side of the magnetic rail **431***b* of the main body portion **431***a*. The power supply unit **431***d* is a battery that supplies power to the electrostatic chuck **431** so that the electrostatic chuck **431** can chuck and maintain the substrate **2**, and the CPS module **431***c* is a wireless charging module for charging the power supply unit **431***d*. In detail, the charging track **423** formed on the second conveyer unit **420** is connected to an inverter. When the carrier **431** is transferred to the second conveyer unit **420**, a magnetic field is formed between the charging track **423** and the CPS module **431***c* which supplies power to the CPS module **431***c*. The power supplied to the CPS module **431***c* is used to charge the power supply unit **431***d*.

The electrostatic chuck **432** is formed by embedding an electrode into a ceramic main body, and attaches the substrate **2** to a surface of the main body by applying a high voltage to the electrode.

Next, an operation of the moving unit **430** will be described in detail.

The magnetic rail **431***b* of the main body portion **431***a* and the coil **411** may be coupled to each other to constitute a driving unit. The driving unit may be a linear motor. A linear motor has a small friction coefficient, little positioning error, and a high degree of position determination as compared to a conventional slide guide system. As described above, a linear motor may include the coil **411** and the magnetic rail **431***b*, the magnetic rail **431***b* may be aligned on the carrier **431**, and a plurality of the coils **411** may be disposed at predetermined intervals on a side in the chamber **101** to face the magnetic rail **431***b*. Since the magnetic rail **431***b* is disposed on the movable carrier **431** instead of the coils **411**, the carrier **431** may be driven without supplying power to the carrier **431**. The coils **411** may be disposed in an atmosphere (ATM) box in an atmospheric state, and the magnetic rail **431***b* may be attached to the carrier **431** so that the carrier **431** travels in the chamber **101** that is maintained in vacuum.

The first organic layer deposition assembly **100-1** of the organic layer deposition apparatus **1** may further include a camera for alignment. In detail, the camera may align in real time a mark formed on the substrate **2** with a mark formed on the patterning slit sheet **130**. The camera is provided to more accurately view the vacuum chamber **101** during deposition. To this end, the camera may be provided in a camera receiving unit in an atmospheric state.

The first fixing frame **132**, the second fixing frame **133**, and the pattern sheet **134** will be described in detail.

FIG. **5** is a perspective view of the first fixing frame **132** of FIG. **3**. FIG. **6** is a perspective view of the second fixing frame **133** and the pattern sheet **134** of FIG. **3**. FIG. **7** is a cross-sectional view taken along line VII-VII of FIG. **6**.

Referring to FIGS. **5** through **7**, a first hole **132***a* may be formed in a central portion of the first fixing frame **132**. According to embodiments, a deposition material discharged from the deposition source may pass through the first hole **132***a*. In particular, the deposition material passing through the first hole **132***a* may pass through the pattern sheet **134** disposed over the first hole **132***a* and may be supplied to the substrate **2**.

A second hole **133***e* may be formed in a central portion of the second fixing frame **133** to correspond to the first hole **132***a*. According to embodiments, the pattern sheet **134** may be provided over the second hole **133***e*.

The second fixing frame **133** may have at least one portion whose thickness is different from that of other portions. According to embodiments, the thickness of the at least one portion of the second fixing frame **133** may be less than that of the other portions.

In detail, the second fixing frame **133** may include a first fixing portion **133***a* in which the pattern sheet **134** is fixed. In addition, the second fixing frame **133** may include a second fixing portion **133***b* connected to the first fixing frame **132**. In particular, the second fixing frame **133** may include at least one etching portion **133***c* that is formed in at least one of the first fixing portion **133***a* and the second fixing portion **133***b*. According to embodiments, a thickness of at least one portion of the at least one etching portion **133***c* may be different from that of the first and second fixing portions **133***a* and **133***b*.

The etching portion **133***c* may be formed in various ways. For example, a plurality of etching portions **133***c* may be formed spaced apart from each other. In addition, the etching portion **133***c* may be formed on a surface of the second fixing frame **133** to surround the pattern sheet **134**. However, for convenience of explanation, embodiments may assume that a plurality of etching portions **133***c* spaced apart from each other are formed on the second fixing frame **133**.

At least one etching indentation **133***d* may be formed in a surface of the etching portion **133***c*. According to embodiments, the etching indentation **133***d* may be recessed from the surface of the etching portion **133***c*. In particular, the etching indentation **133***d* may have any of various shapes. For example, the etching indentation **133***d* may have a hemispherical shape, a square pillar shape, or a triangular pillar shape. Also, the etching indentation **133***d* may be any of various types of grooves. In this case, the etching indentation **133***d* is not limited thereto, and may have any shape as long as a depth of the etching indentation **133***d* is less than a thickness of the second fixing frame **133**.

A plurality of the etching indentations **133***d* may be provided, and may be uniformly distributed in the surface of the etching portion **133***c*. Alternatively, one etching indentation **133***d* may be formed over the entire etching portion **133***c*. A plurality of the etching indentations **133***d* may be formed over the entire etching portion **133***c*. For example, a plurality of the etching indentation **133***d* having hemispherical shapes may be provided. Alternatively, some of the etching indentation **133***d* may be formed to have hemispherical shapes and others may be formed to have square pillar shapes. However, for convenience of explanation, it is assumed that a plurality of the etching indentation **133***d* are provided to have hemispherical shapes.

When the plurality of etching indentations **133***d* are formed, the surface of the etching portion **133***c* may have an uneven shape. For example, the surface of the etching portion **133***c* may be formed such that portions in which the etching indentation **133***d* are formed are recessed and portions in which the etching grooves **133***d* are not formed are protruded.

In this case, a depth h1 of each of the etching indentations **133***d* may be less than a thickness H1 of a portion in which the etching indentations **133***d* are not formed. In detail, the depth h1 of the etching indentations **133***d* may be 0.5 times the thickness H1 of the portion in which the etching indentations **133***d* are not formed. For example, suppose the thickness H1 of the etching portion **133***c* in which the etching indentations **133***d* are not formed is 0.05 mm, then the depth h1 of the etching indentations **133***d* may be 0.0025 mm.

The pattern sheet **134** may be provided on the second fixing frame **133**. According to embodiments, the pattern sheet **134** may be fixed to the second fixing frame **133** by, for example, welding. In particular, the pattern sheet **134** may be fixed to an outer surface of the second fixing frame **133** to face the first fixing frame **132**.

The patterning slit sheet **130** as described above may be manufactured by, for example, welding. In detail, the pattern sheet **134** may be fixed by welding to the second fixing frame **133**, and then the second fixing frame **133** and the first fixing frame **132** may be fixed by welding. According to embodiments, the first fixing frame **132** and the pattern sheet **134** on the second fixing frame **133** may be provided to face each other as described above.

When the first fixing frame **132** and the second fixing frame **133** are connected to each other by welding as described above, a counter force may be applied to the first hole **132***a* of the first fixing frame **132**. According to embodiments, a tensile force may be applied to the outside of the second hole **133***e* of the second fixing frame **133**.

When a force is applied to the second fixing frame **133** as described above, the pattern sheet **134** may be prevented from bending due to its weight. In addition, when a force is applied to the first fixing frame **132**, the second fixing frame **133** may be prevented from returning to its original position due to its restoring force. In detail, when the first fixing frame **132** and the second fixing frame **133** are fixed as described above, the second fixing frame **133** tends to deform into the second hole **133***e* due to a second restoring force, and the first fixing frame **132** tends to deform out of the first hole **132***a* due to a first restoring force. According to embodiments, since the first restoring force and the second restoring force are opposite in direction, the first and second restoring forces offset each other, thereby maximally maintaining a position after the pattern sheet **134** is fixed.

According to embodiments, the etching portion **133***c* may reduce a tensile force that occurs when the second fixing frame **133** elongates. In particular, since a portion of the etching portion **133***c* in which the etching indentations **133***d* are formed has a thickness less than that of other portions, the portion may be elongated with a small tensile force. In addition, the portion of the etching portion **133***c* in which the etching indentations **133***d* are not formed may prevent the etching indentations **133***d* from being torn or damaged due to a tensile force generated in the portion in which the etching indentations **133***d* are formed. In particular, to reinforce a strength of the etching portion **133***c*, the portion of the etching portion **133***c* in which the etching indentations **133***d* are not formed may have the same thickness as that of the first or second fixing portions **133***a* and **133***b*, preventing damage to the etching portion **133***c* when the second fixing frame **133** elongates.

Since the second fixing frame **133** may be provided on the first fixing frame **132** with a small tensile force, an initial position of the pattern sheet **134** may be maintained in the presence of the first restoring force and the second restoring force after the pattern sheet **134** is provided.

In detail, when the first fixing frame **132** and the second fixing frame **133** are fixed, an initial position of the pattern sheet **134** may be determined due to the first restoring force and the second restoring force. In this case, as time passes and the first restoring force and the second restoring force change with respect to each other, the initial position may change. When a position of the pattern sheet **134** differs from the initial position, a position of the organic layer deposited on the substrate **2** changes, which may reduce pixel position accuracy (PPA), thereby reducing resolution and brightness of the organic light-emitting display apparatus. In particular, the risk that the position of the pattern sheet **134** differs from the initial position may increase as the first restoring force and the second restoring force increase.

However, the organic layer deposition apparatus includes the etching portion **133***c* to minimize the first and second restoring forces, which minimizes the risk that a position of the pattern sheet **134** may change.

Accordingly, an organic layer deposition apparatus may accurately deposit an organic layer and may improve PPA by using the etching portion **133***c*.

FIG. **8** is a perspective view of a second fixing frame **133'** of FIG. **3**, according to another embodiment of the present disclosure. FIG. **9** is a cross-sectional view taken along line IX-IX of FIG. **8**.

Referring to FIGS. **8** and **9**, the second fixing frame **133'** may be formed in a manner similar to that described above. According to embodiments, the second fixing frame **133'** may include a first fixing portion **133***a*', a second fixing portion **133***b*', an etching portion **133***c*', and second hole **133***e*' in a central portion thereof. The etching portion **133***c*' may include etching indentations **133***d*'

The etching indentation **133***d*' may have any of various shapes as described above. In addition, a plurality of the etching indentations **133***d*' may be provided spaced apart from each other. However, for convenience of explanation, embodiments may assume that the etching indentations **133***d*' have a square pillar shape and the etching portion **133***c*' has a connected shape.

The etching indentations **133***d*' in the etching portion **133***c*' may have a square shape. In this case, the etching indentations **133***d*' may be recessed from a surface of the etching portion **133***c*' as described above, and the etching portion **133***c*' may have an uneven surface. In particular, the etching indentations **133***d*' may be formed by etching using a photo mask. In this case, etching using the photo mask is sufficiently similar to a general etching method that a detailed explanation thereof will not be given.

A depth h2 of the etching indentations **133***d*' may differ from a thickness H2 of the etching portion **133***c*' in which the etching indentations **133***d*' are not formed. According to embodiments, the depth h2 of the etching indentations **133***d*' may be less than the thickness H2 of the etching portion **133***c*' in which the etching indentations **133***d*' are not formed.

The second fixing frame **133'** as described above may be coupled to the first fixing frame **132'** and the pattern sheet **134'** in an identical or similar manner to that described above. According to embodiments, the second fixing frame **133'** may be coupled to the first fixing frame **132'** with a small tensile force. In particular, the etching portion **133***c*' may reduce a tensile force applied to the second fixing frame **133'** as described above.

Accordingly, an organic layer deposition apparatus may accurately deposit an organic layer using the etching portion **133***c*, and may improve PPA.

FIG. **10** is a perspective view of an organic layer deposition assembly **900** according to another embodiment of the present disclosure.

Referring to FIG. **10**, the organic layer deposition assembly **900** includes a deposition source **910**, a deposition source nozzle unit **920**, and a patterning slit sheet **950**. In addition, the organic layer deposition assembly **900** further includes a source shutter.

The deposition source **910** includes a crucible **911** in which a deposition material **915** is filled, and a heater **912** that heats the crucible **911** to vaporize the deposition material **915** to flow toward the deposition source nozzle unit **920**. The deposition source nozzle unit **920** is disposed at one side of the deposition source **910**, and includes a plurality of deposition source nozzles **921** disposed in a Y-axis.

The patterning slit sheet **950** may be further provided between the deposition source **910** and the substrate **2**. The patterning slit sheet **950** may include a first fixing frame **953**, a second fixing frame **954**, and a pattern sheet **955**. According to embodiments, a plurality of patterning slits **951** and spacers **952** are formed in an X-axis direction in the pattern sheet **955**. The first deposition source **910**, the deposition source nozzle unit **920**, and the patterning slit sheet **950** are coupled to one another by connection members **935**.

The plurality of deposition source nozzles **921** provided in the deposition source nozzle unit **920** are arranged differently from those in previous embodiments, which will be described in detail.

The deposition source nozzle unit **920** is disposed at one side of the deposition source **910**, in detail, at a side of the deposition source **910** facing the substrate **2**. The deposition source nozzles **921** are formed in the deposition source nozzle unit **920**. The deposition material **915** evaporating in the deposition source **910** are discharged through the deposition source nozzles **921** and flow toward the substrate **2** on which deposition is to be performed. According to embodiments, if the plurality of deposition source nozzles **921** are provided in the X-axis direction, distances from the deposition source nozzles **921** to the pattern slits **951** may differ from each other, and thus shadows may occur due to deposition material being discharged from a deposition source nozzle **921** far from the patterning slit **951**. Accordingly, the deposition source nozzles **921** are disposed in a Y-direction such that each deposition source nozzle **921** is a same distance from the same patterning slit **951**, which may reduce shadow occurrences.

The source shutter may be provided between the connection members **935**.

FIG. **11** is a cross-sectional view of an active matrix organic light-emitting display apparatus manufactured using an organic layer deposition apparatus, according to an embodiment of the present disclosure.

Referring to FIG. **11**, an active matrix organic light-emitting display apparatus is formed on the substrate **2**. The substrate **2** may be formed of a transparent material, such as glass, plastic, or a metal. An insulating film **51** such as a buffer layer is formed over the entire substrate **2**.

A thin film transistor (TFT) and an organic light-emitting device (OLED) are formed on the insulating film **51** as shown in FIG. **11**.

A semiconductor active layer **52** arranged in a predetermined pattern is formed on a top surface of the insulating film **51**. The semiconductor active layer **52** is covered by a gate insulating film **53**. The semiconductor active layer **52** may include a p-type or n-type semiconductor.

A gate electrode **54** of the TFT is formed on a top surface of the gate insulating film **53** to correspond to the semiconductor active layer **52**. An interlayer insulating film **55** is formed to cover the gate electrode **54**. After the interlayer insulating film **55** is formed, the gate insulating film **53** and the interlayer insulating film **55** are etched using an etching process such as dry etching to form a contact hole through which a portion of the semiconductor active layer **52** is exposed.

Next, source electrode **56** and drain electrode **57** are formed on the interlayer insulating film **55** to contact the portion of the semiconductor active layer **52** exposed through the contact hole. A protective film **58** is formed to cover the source electrode **56** and drain electrode **57**, and a portion of the drain electrode **57** is exposed using an etching process. An insulating film **59** may be further formed on the protective film **58** to planarize the protective film **58**.

An organic light-emitting device (OLED) displays predetermined image information by emitting red, green, and blue light as current flows. The OLED includes a first electrode **61** formed on the protective film **58** that is electrically connected to the drain electrode **57** of the TFT.

A pixel-defining film **60** is formed to cover the first electrode **61**. After an opening is formed in the pixel-defining film

60, an organic layer 62 that includes an emission layer is formed in an area defined by the opening. A second electrode 63 is formed on the organic layer 62.

The pixel-defining film 60 that defines individual pixels is formed of an organic material, and planarizes a surface of a substrate on which the first electrode 61 is formed, in particular, a surface of the insulating film 59.

The first electrode 61 and the second electrode 63 are insulated from each other, and apply voltages of opposite polarities to the organic layer 62 that includes the emission layer to emit light.

The organic layer may use a low molecular weight organic material or a high molecular weight organic material. If the organic layer includes a low molecular weight organic material, the organic layer may have a single or multi-layer structure that includes a hole injection layer (HIL), a hole transport layer (HTL), an emission layer (EML), an electron transport layer (ETL), and an electron injection layer (EIL). Examples of available organic materials may include copper phthalocyanine (CuPc), N,N'-di(naphthalene-1-yl)-N,N'-diphenyl-benzidine (NPB), and tris-8-hydroxyquinoline aluminum (Alq_3).

The organic layer 62 may be deposited by the organic layer deposition apparatus 1 that includes a deposition source that discharges a deposition material, a deposition source nozzle unit disposed at a side of the deposition source and having a plurality of deposition source nozzles formed therein, and a patterning slit sheet disposed to face the deposition source nozzle unit and having a plurality of patterning slits formed therein, as shown in FIG. 1. After the organic layer deposition apparatus is disposed to be spaced apart from a substrate on which deposition is to be performed, the deposition material discharged by the organic layer deposition apparatus 1 is deposited on the substrate 2 as the organic layer deposition apparatus 1 and the substrate 2 move relative to each other.

After the organic light-emitting film is formed, the second electrode 63 is formed using the same deposition process.

The first electrode 61 may function as an anode whereas the second electrode 63 may function as a cathode, or vice versa. The first electrode 61 may be patterned to correspond to each pixel area, and the second electrode 63 may be formed to cover all pixels.

The first electrode 61 may be a transparent electrode or a reflective electrode. If the first electrode 61 is a transparent electrode, the first electrode 61 may include indium tin oxide (ITO), indium zinc oxide (IZO), zinc oxide (ZnO), or indium oxide (In_2O_3). If the first electrode 61 is a reflective electrode, the first electrode 61 may be formed by forming a reflective layer using silver (Ag), magnesium (Mg), aluminum (Al), platinum (Pt), palladium (Pd), gold (Au), nickel (Ni), neodymium (Nd), iridium (Ir), chromium (Cr), or a compound thereof, and then forming a transparent electrode layer on the reflective layer using ITO, IZO, ZnO, or In_2O_3. The first electrode 61 may be formed using sputtering and then may be patterned using photolithography.

The second electrode 63 may also be a transparent electrode or a reflective electrode. If the second electrode 63 is a transparent electrode, since the second electrode 63 is used as a cathode, the transparent electrode may be formed by depositing a metal having a low work function, such as, lithium (Li), calcium (Ca), lithium fluoride/calcium (LiF/Ca), aluminum (Al), silver (Ag), magnesium (Mg), or a compound thereof to face the organic layer 62, and then forming an auxiliary electrode layer or a bus electrode line thereon by using ITO, IZO, ZnO, or In_2O_3. If the second electrode 63 is a reflective electrode, the second electrode 63 is formed by depositing Li, Ca, LiF/Ca, LiF/Al, Al, Ag, Mg, or a compound thereof. According to embodiments, the deposition may be performed in the same manner as that used to form the organic layer 62.

Embodiments of the present disclosure may also be used to deposit an organic layer or an inorganic film of an organic TFT, and to form films using various other materials.

According to the embodiments of the present disclosure, since a thickness of at least one portion of a second fixing frame is different from thicknesses of other portions of the second fixing frame to reduce a tensile force applied thereto, deformation or deviation of a pattern sheet may be minimized.

While embodiments of the present disclosure has been particularly shown and described with reference to exemplary embodiments thereof, it will be understood by those of ordinary skill in the art that various changes in form and details may be made therein without departing from the spirit and scope of the present disclosure as defined by the following claims.

What is claimed is:

1. A method of manufacturing an organic light-emitting display apparatus using an organic layer deposition apparatus, the method comprising:
- fixing a substrate to a moving unit;
- transferring the moving unit to which the substrate is fixed into a chamber by using a first conveyer unit that is configured to enter the chamber, wherein the substrate is spaced apart from an organic layer deposition assembly disposed in the chamber by a predetermined interval;
- depositing a deposition material discharged from the organic layer deposition assembly on the substrate while the substrate moves relative to the organic layer deposition assembly, to form an organic layer;
- separating the substrate from the moving unit; and
- returning the moving unit using a second conveyer unit that is configured to enter the chamber,
- wherein the organic layer deposition assembly comprises:
  - at least one deposition source configured to discharge the deposition material; and
  - a patterning slit sheet that is disposed to face each of a plurality of deposition sources,
- wherein the deposition material discharged from the organic layer deposition assembly flows through the patterning slit sheet to form a pattern on the moving substrate,
- wherein the patterning slit sheet comprises:
- a first fixing frame;
- a second fixing frame attached to the first fixing frame the second fixing frame having at least one portion whose thickness is less than thicknesses of other portions; and
- a pattern sheet that is fixed to the second fixing frame to face the organic layer deposition assembly, and which has a plurality of patterning slits.

2. The method of claim 1, wherein the second fixing frame comprises:
- a first fixing portion to which the pattern sheet is fixed;
- a second fixing portion to which the first fixing frame is fixed; and
- at least one etching portion formed on at least one of the first fixing portion and the second fixing portion and has at least one portion whose thickness is different from a thickness of the at least one of the first fixing portion and the second fixing portion.

3. The method of claim 2, wherein at least one etching indentation is formed in a surface of the at least one etching portion.

4. The method of claim **2**, wherein the at least one etching portion surrounds an edge of the pattern sheet.

5. The method of claim **1**, wherein the moving unit is configured to be transferred between the first conveyer unit and the second conveyer unit, and the substrate fixed to the moving unit is spaced apart from the organic layer deposition assembly by a predetermined interval while being moved by the first conveyer unit.

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